RECLAMATION

Managing Water in the Wes

Nonstructural Hazards Mitigation:

Identification, Quantification and Mitigation

U.S. Department of the Interior
Bureau of Reclamation

Presentation Topics

What are Nonstructural Components

Why are they Hazardous

Target Buildings Guidelines

Reclamation's Approach to Nonstructural Hazards Mitigation

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Nonstructural Components

CUREE – Consortium of Universities for Research in Earthquake Engineering

Wood Frame Structure with Nonstructural Components

Why mitigate the nonstructural hazards?

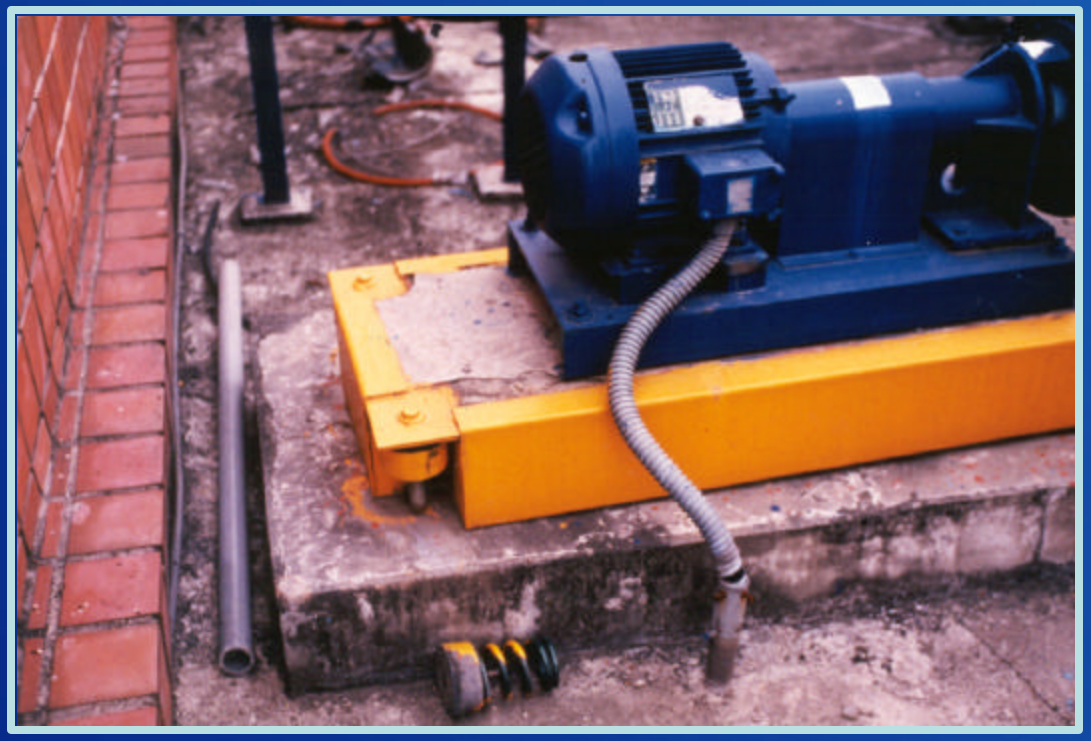
- Prevent falling hazards

Why mitigate the nonstructural hazards?

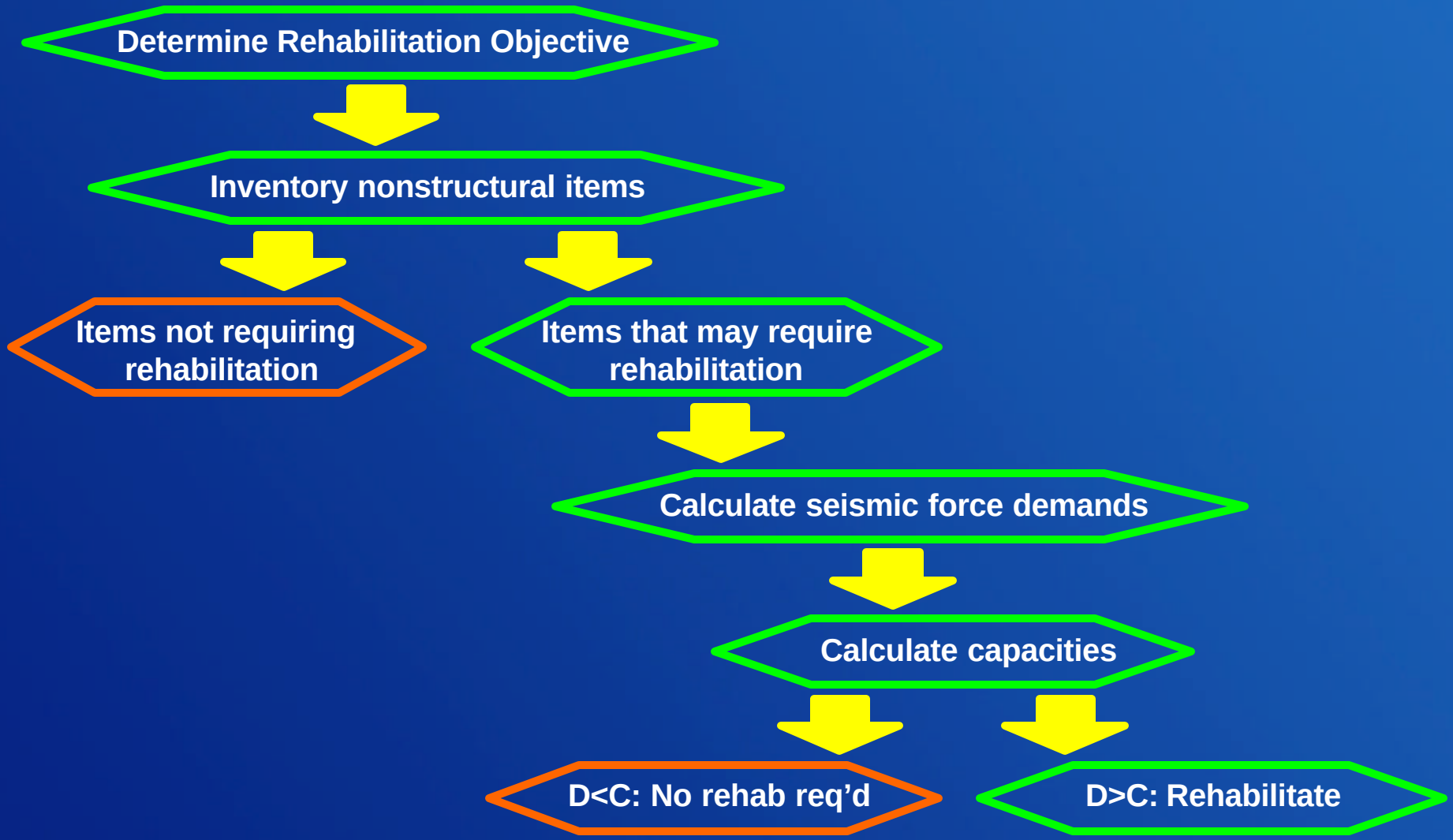
- Ensure clear egress routes

Why mitigate the nonstructural hazards?

- Maintain emergency & lifeline utilities
  - Power, water, gas, telephone



Seismic Rehabilitation Process



Component Categorization

- Not part of the structural system –
- 4 Component Categories
  - Architectural
  - Mechanical Equipment
  - Electrical and Communications
  - Furnishings and Interior Equipment

Nonstructural Components

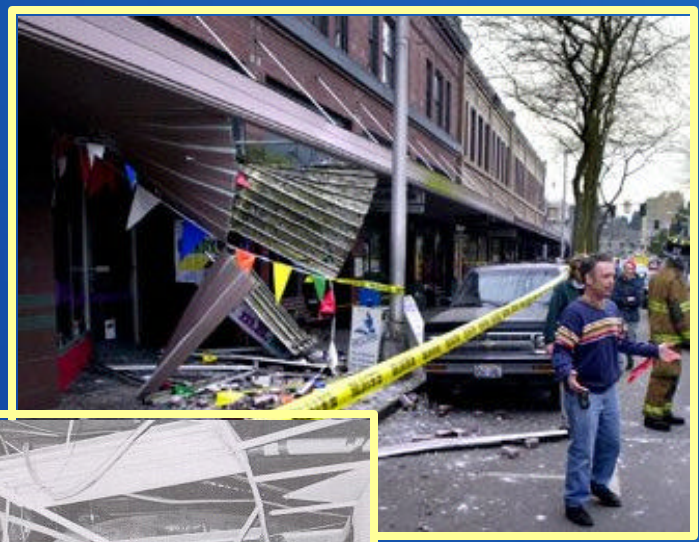
Sub-Categories or Components

Architectural Components

- ✓ Interior and Exterior Wall Elements
- ✓ Partitions
- ✓ Ceilings
- ✓ Parapets/Appendages
- ✓ Canopies or Marquees
- ✓ Chimneys
- ✓ Stairs

Architectural Component Hazards

Wall Elements



Canopies

Ceilings

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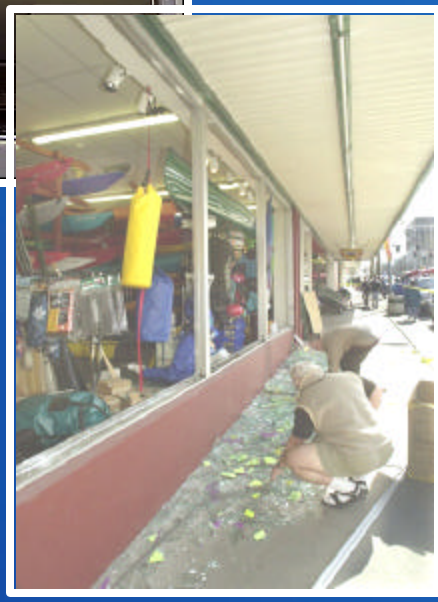
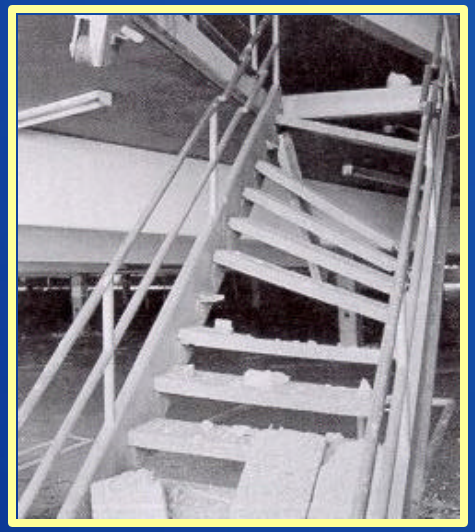
Architectural Component Hazards

Chimneys

Glazing





Stairs

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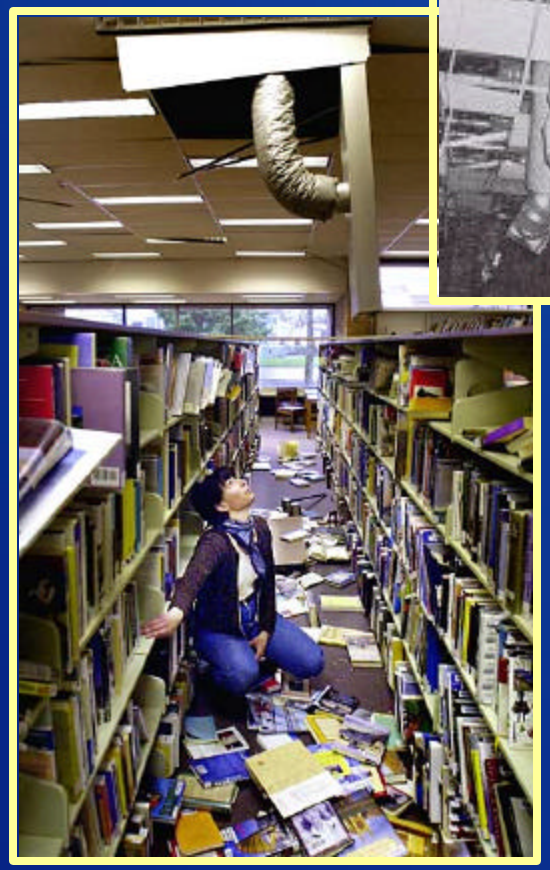
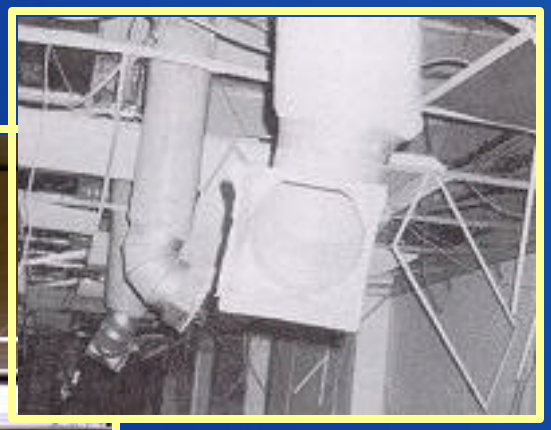
Nonstructural Components

Mechanical Equipment

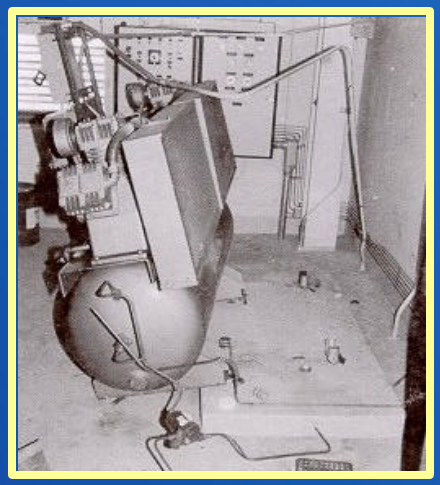
- ✓ Storage Vessels and Water Heaters, HVAC
- ✓ Piping
  - ✓ Hazardous or non-hazardous
- ✓ Ductwork

Mechanical Equipment Hazards



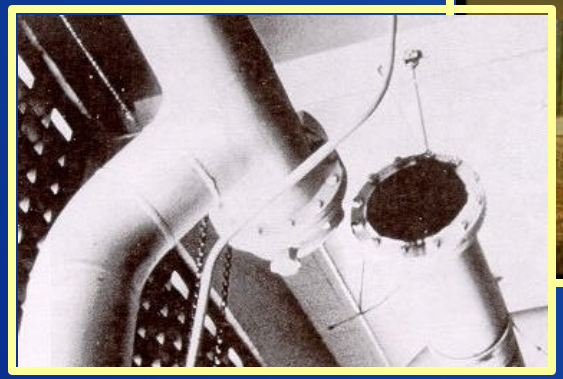


HVAC



Equipment

Piping



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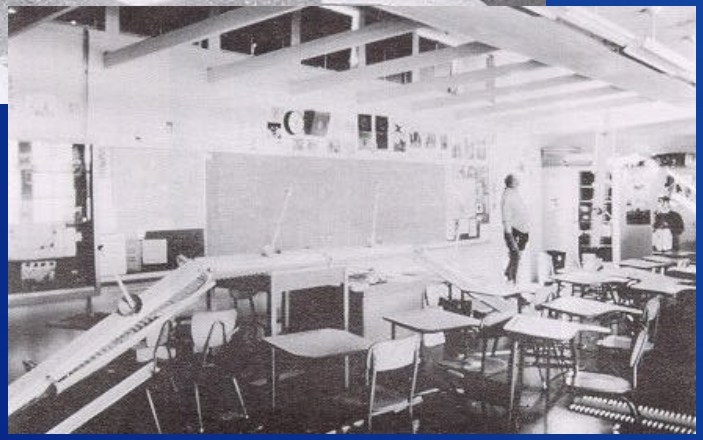
Nonstructural Components

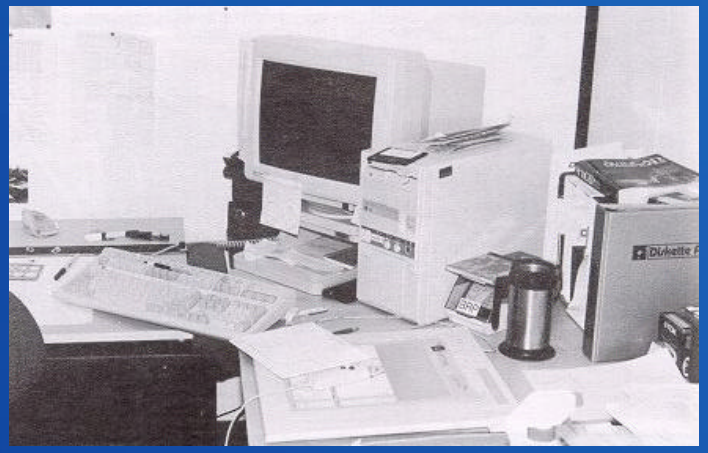
Electrical and Communications

- ✓ Equipment
- ✓ Distribution
- ✓ Light Fixtures
  - ✓ Recessed, surface-mounted, suspended ceiling system and pendant

Electrical and Communication Systems Hazards



Lighting



Computers

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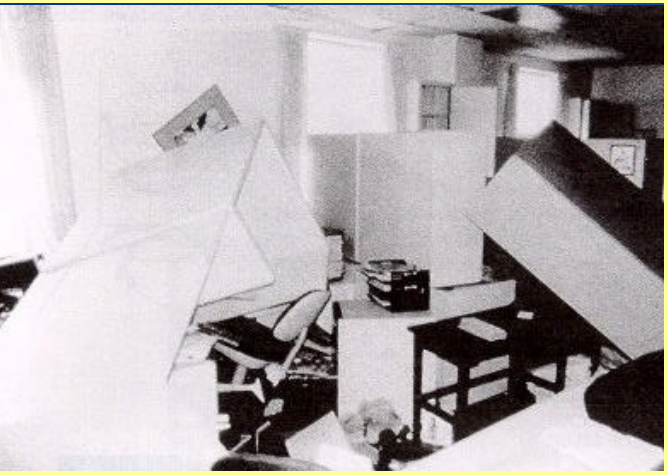
Nonstructural Components

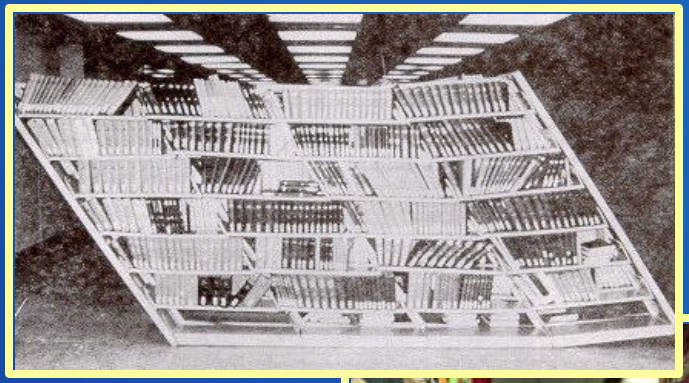
Furnishings and Interior Equipment

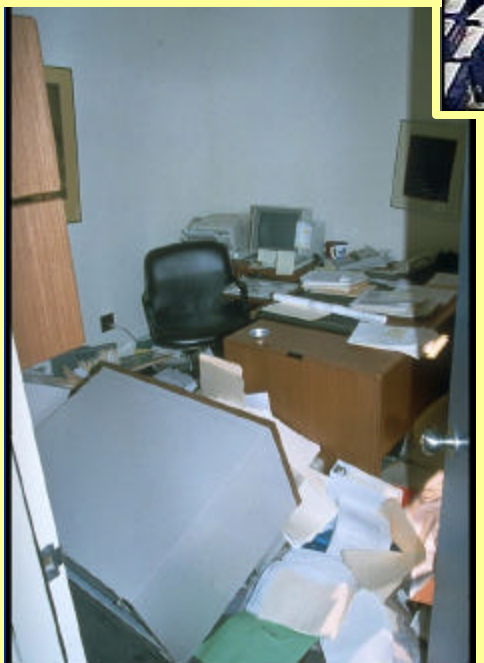
- ✓ Storage Racks, Bookcase
- ✓ Hazardous Material Storage
- ✓ Furnishings
- ✓ Computer and Communication Racks
- ✓ Elevators and Conveyors

Furnishings and Interior Equipment Hazards



Bookcases





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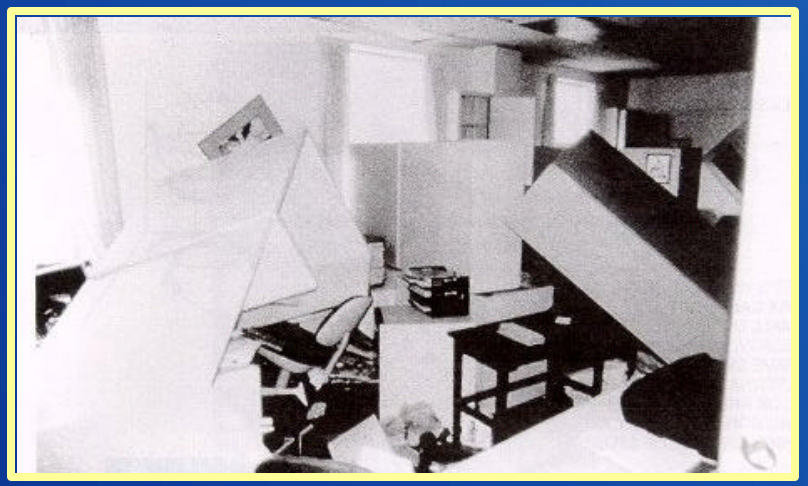
Performance Expectations
Nonstructural Components

Safety Performance

- ✓ Level of Component Performance
- ✓ Base Performance is Safe Egress



Safety Performance

Life Safety Performance Level

Fully Functional …….. EQ Causes NO DAMAGE

Immediate Occupancy …… EQ Causes MINOR DAMAGE but Building is completely operational

Life Safety…… **EQ Causes SERIOUS DAMAGE but Safe Occupant Egress is provided**

Hazards Reduced ……..…… EQ Causes SERIOUS DAMAGE but Building does not Collapse - Other loss is accepted

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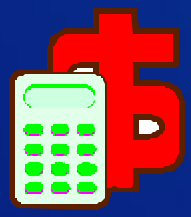
Performance Expectations
Nonstructural Components

Economic Performance

- ✓ Business Disruption
- ✓ Component Repair
- ✓ Component Replacement

Economic Performance Considerations

- ✓ Benefit Cost Ratio – Cost / Benefit should be greater than 1
  - ✓ Average Cost for Repair
    $ 5.92 / sq ft (Study done after Northridge)
  - ✓ Cost for Business Interruption with Extensive Damage
    $ 25.21 / sq ft (Study done after Northridge)
  - ✓ Average Cost for Mitigation Nonstructural Components
    $ 3.30 / sq ft (FEMA 157)

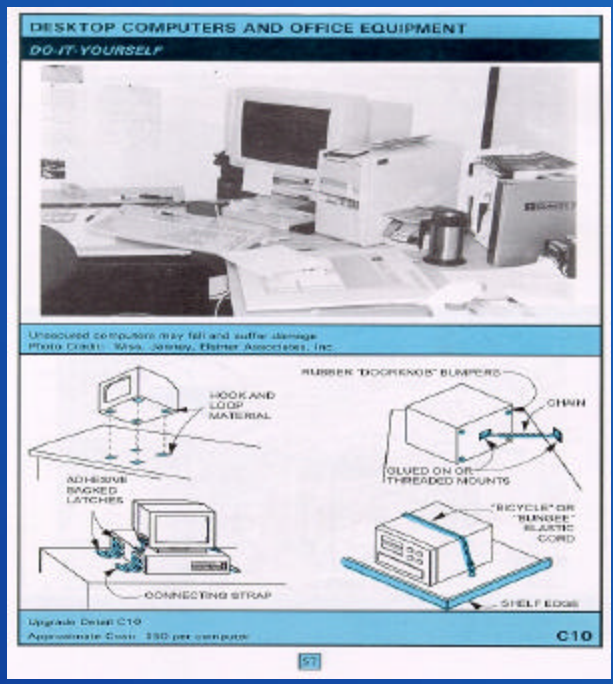


Benefit Cost Ratio:

(25.21+5.92) / 3.3 = 9.43

How Much Does it Cost?

- ✓ Labor and Material Costs of……$25
  Mitigation
- ✓ Cost of Material Replacement..$900
- ✓ Cost of Down Time……..$500



Benefit Cost Ratio:
1400/25 = 56

Does not include:

Loss of Data
Loss of Productivity
Loss of Business

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Failure Mechanisms

Component Hazard Classification

- ✓ Acceleration Sensitive
- ✓ Deformation Sensitive
- ✓ Overturning

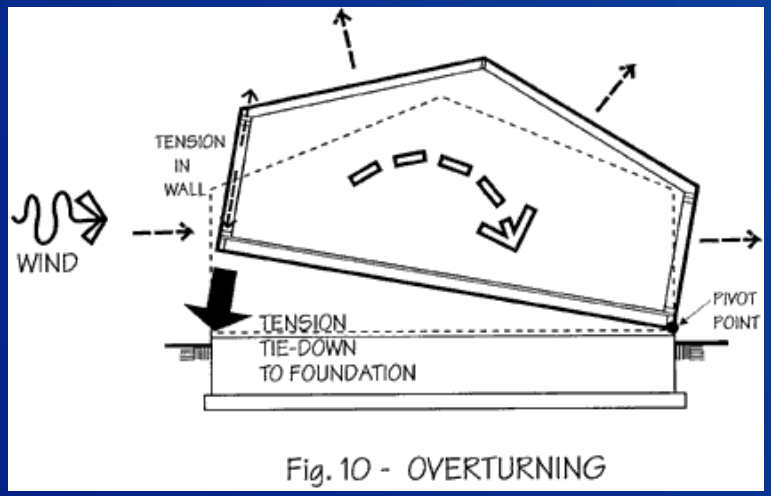
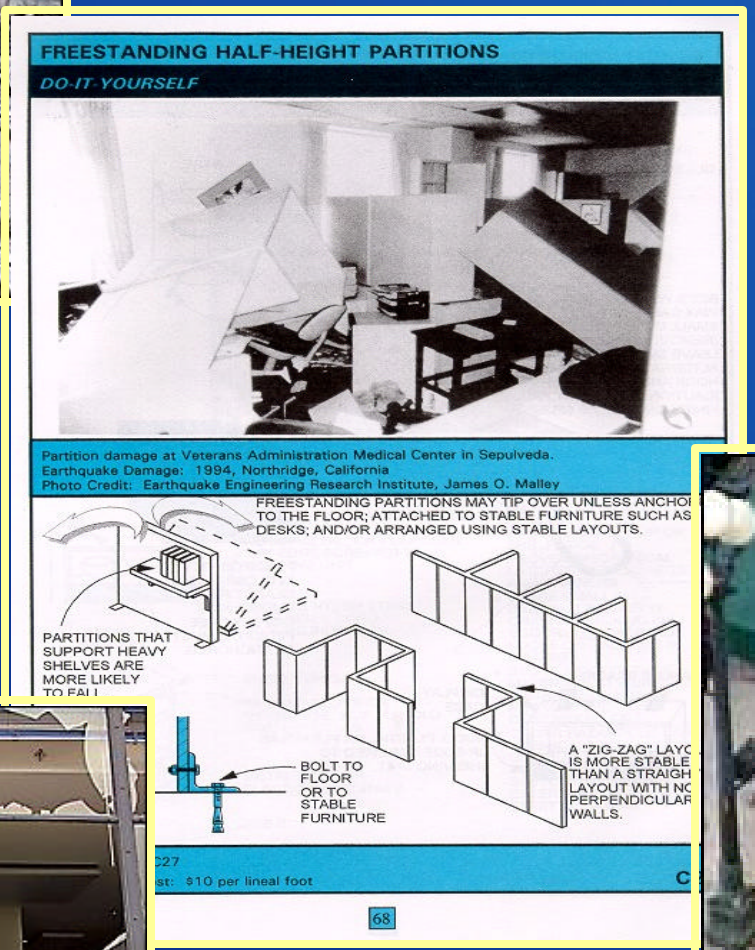
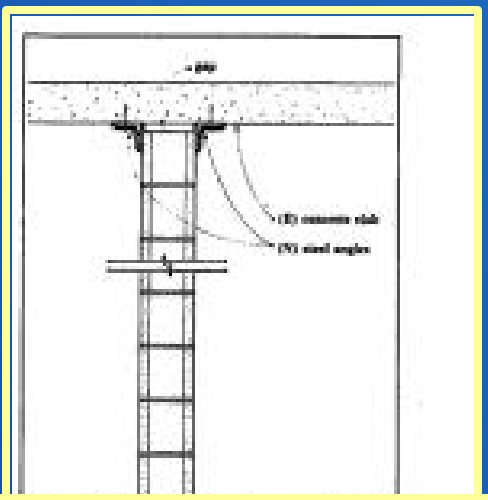


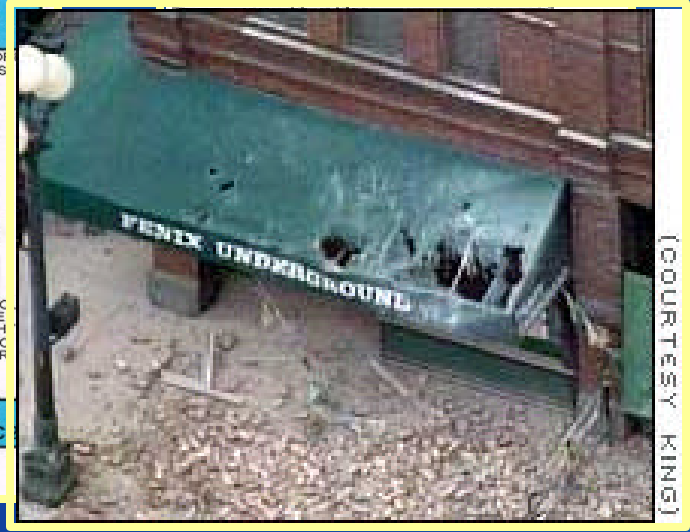
Fig. 10 - OVERTURNING

Architectural Component

Wall Elements







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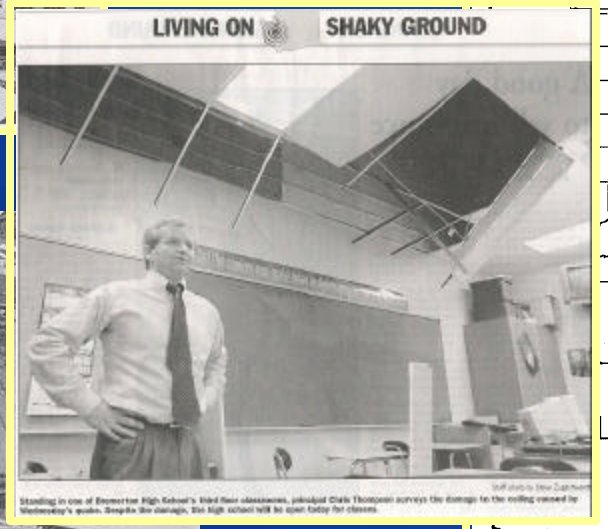
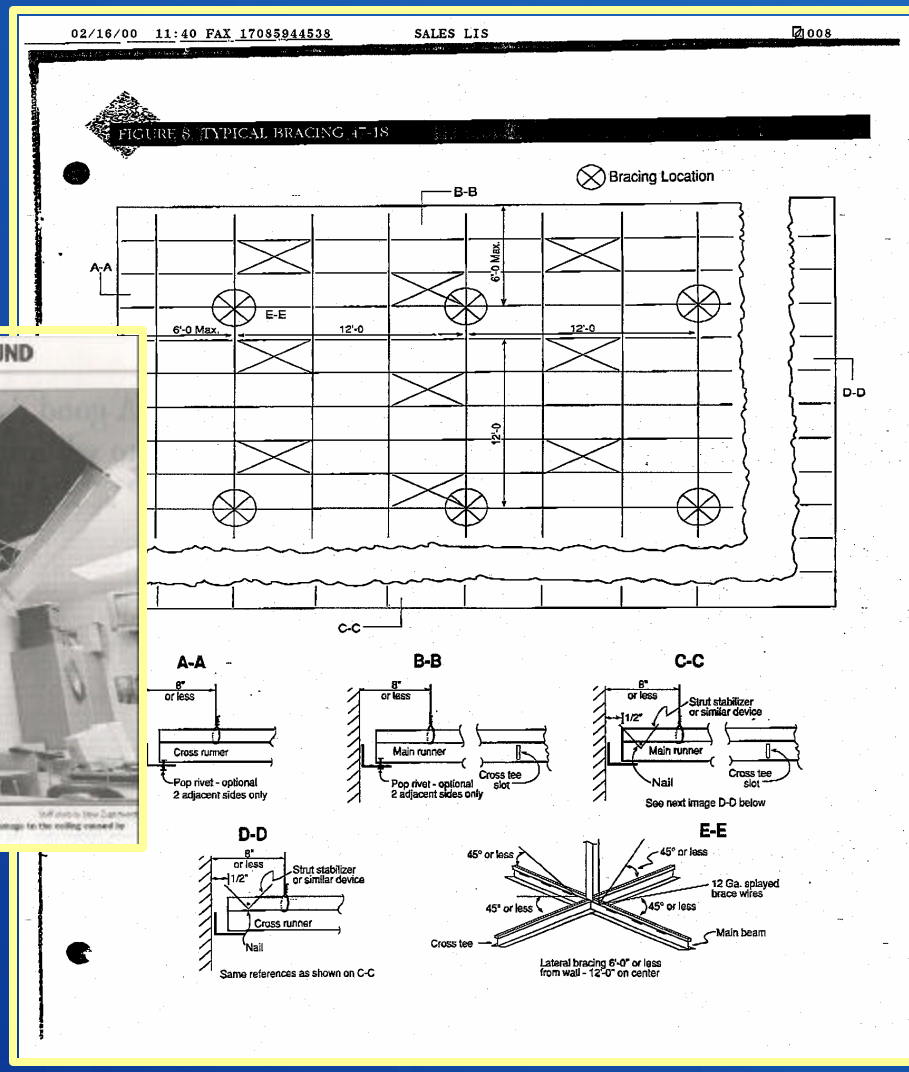
Architectural Component

Ceilings





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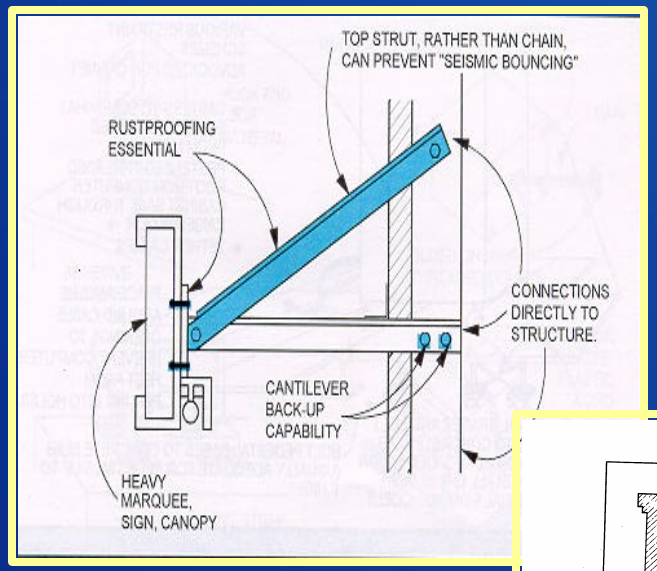
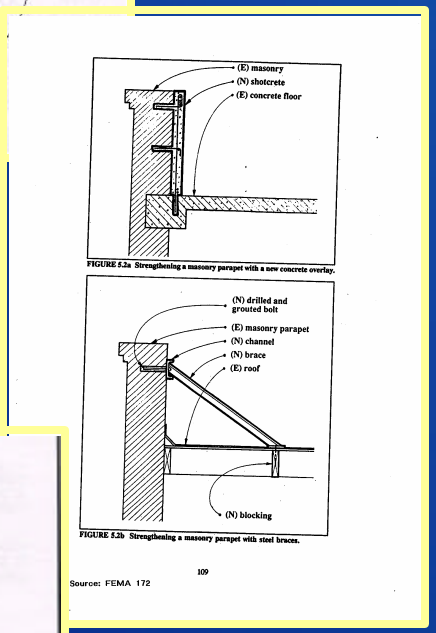
Architectural Component

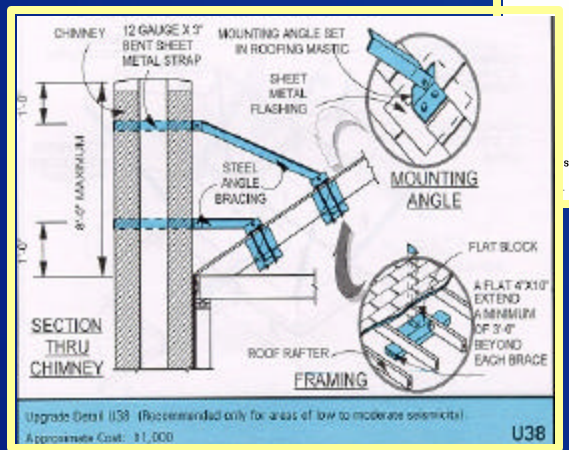
Parapets/Appendages

Canopies or Marquees

Chimneys







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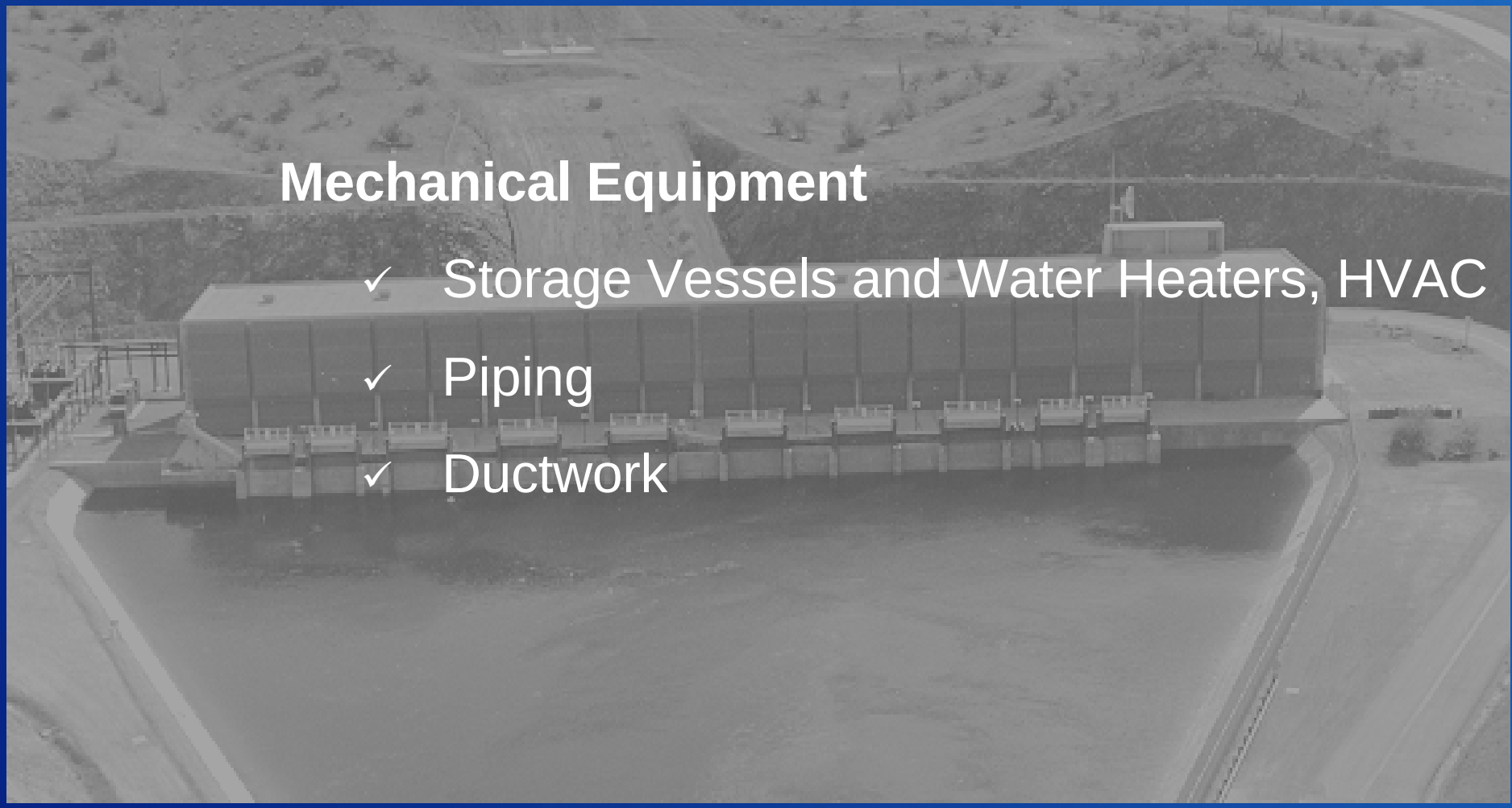
Architectural Component

Stairs and Stair Enclosures

URM WALLS: Walls around stair enclosures consisting of hollow clay tile or unreinforced masonry shall be braced to the structure for seismic forces. (Tier 2: Sec. 4.8.10.1).

STAIR DETAILS: In moment frame structures, the connections between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check Procedure of Section 3.5.3.1 without inducing tension in the anchors. (Tier 2: Sec. 4.8.10.2).

Nonstructural Components



Mechanical Equipment

- ✓ Storage Vessels and Water Heaters, HVAC
- ✓ Piping
- ✓ Ductwork

Mechanical Components

Mechanical Equipment

Storage Vessels and Water Heaters

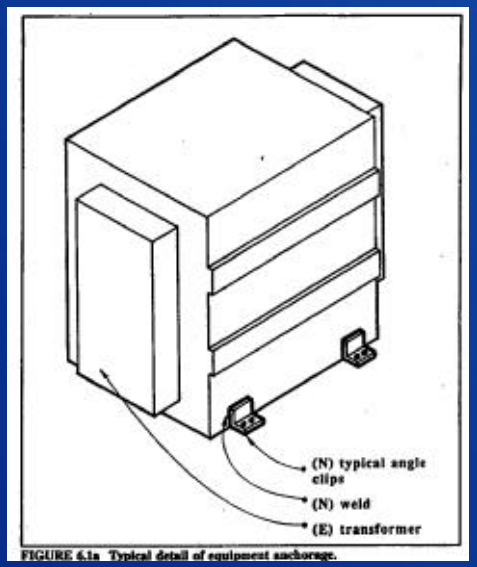
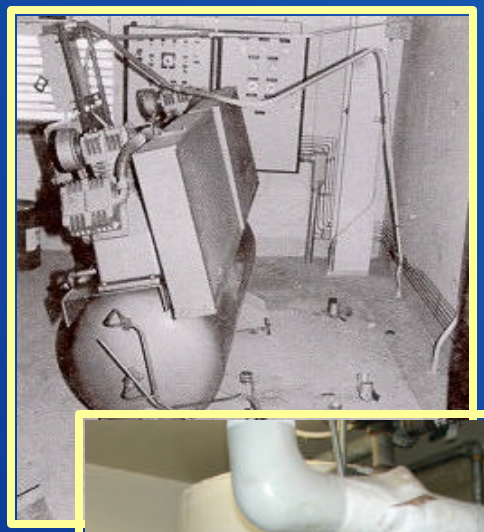
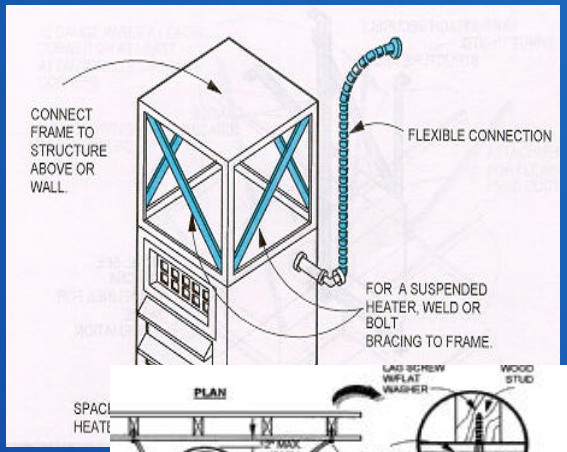
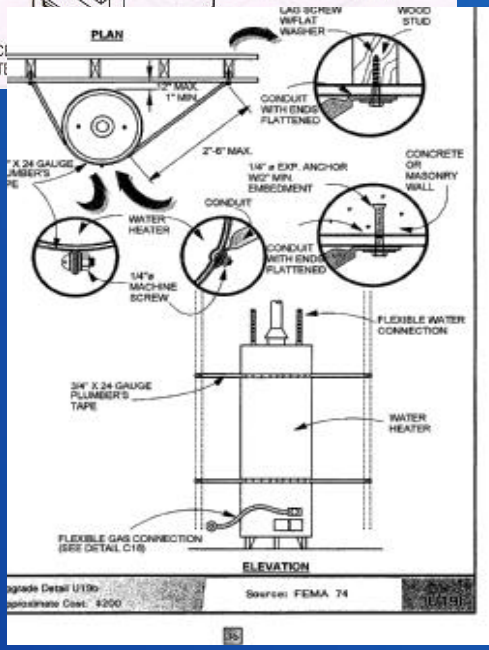


FIGURE 6.1a Typical detail of equipment anchorage.







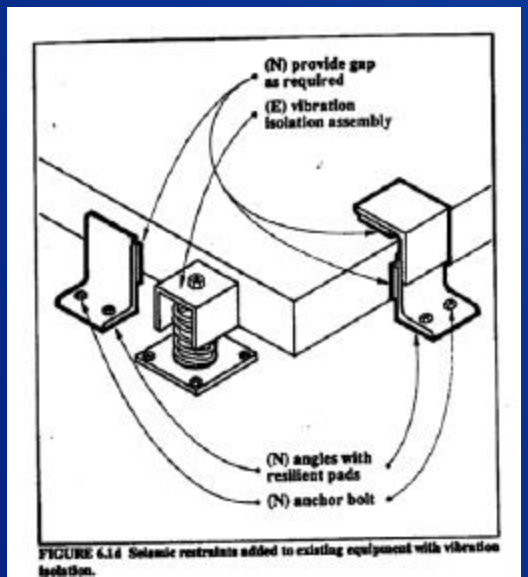


FIGURE 6.1d Seismic restraints added to existing equipment with vibration isolation.

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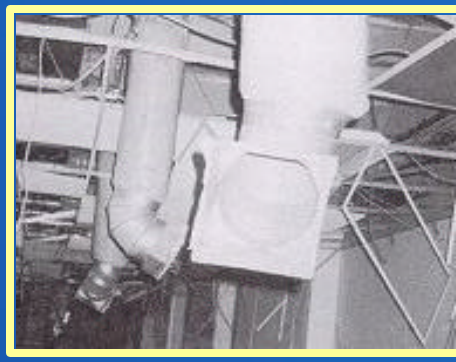
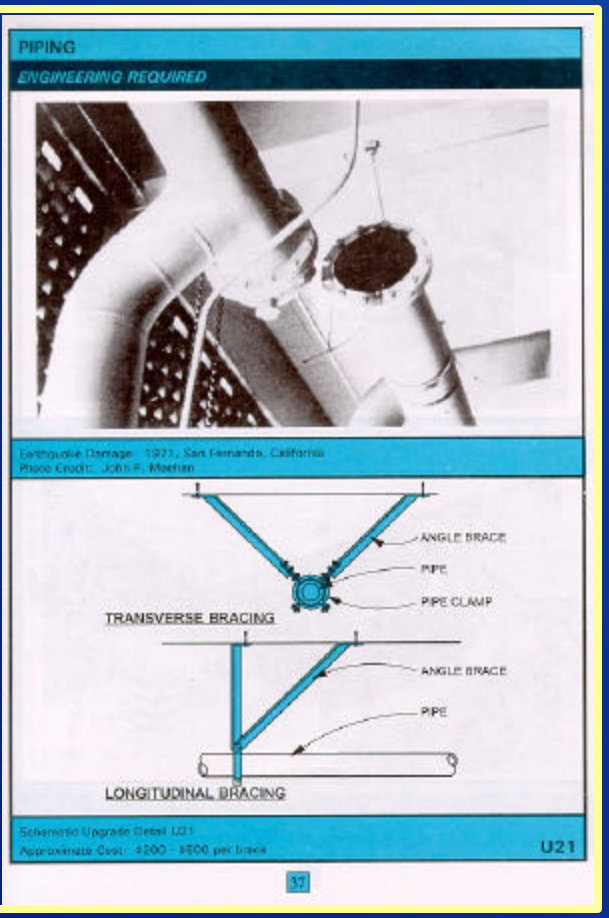
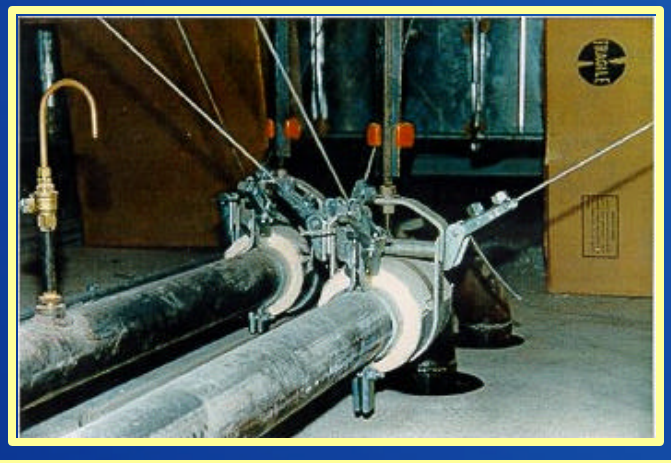
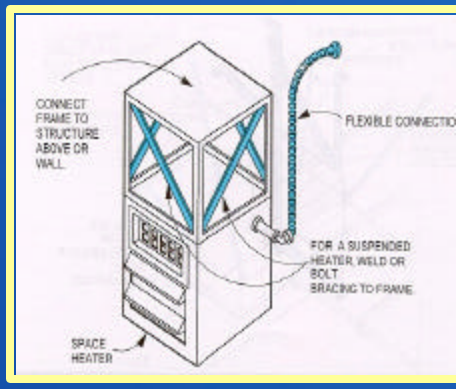
Mechanical Components

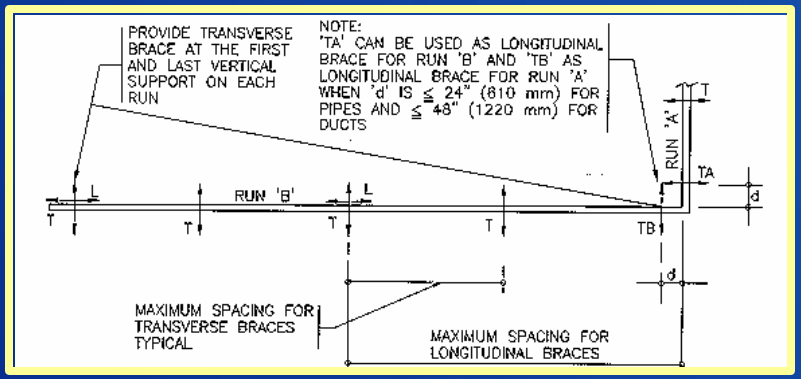
- Pressure Piping
- Fire Suppression Piping
- Fluid Piping, not Fire Suppression
- Ductwork

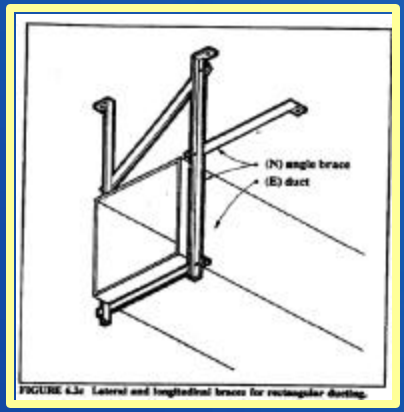












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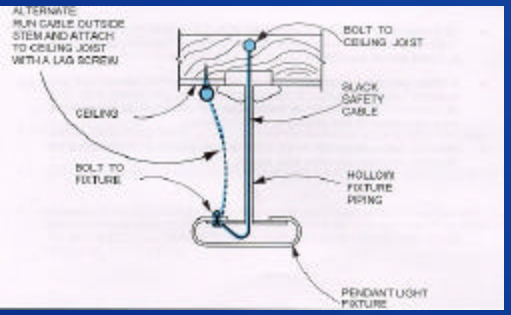
Nonstructural Components

Electrical and Communications

- ✓ Equipment
- ✓ Light Fixtures

Electrical and Communication Systems



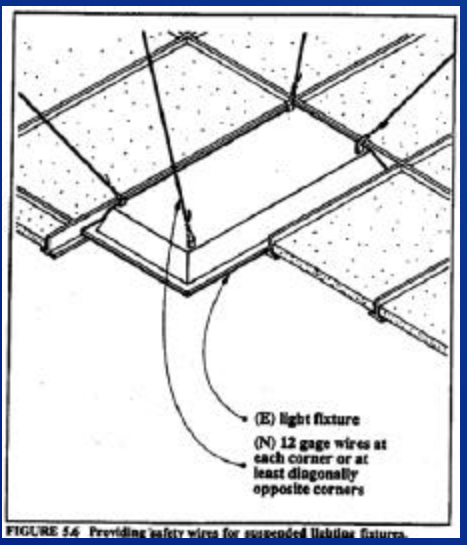
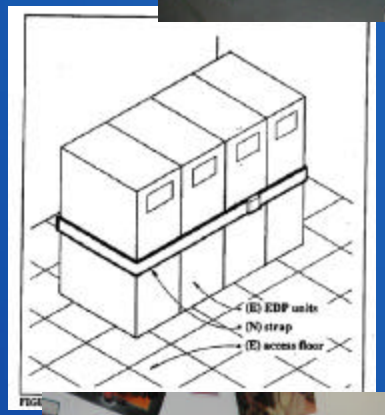


FIGURE 5.6 Providing safety wires for suspended lighting fixtures.

- Equipment
- Distribution Equipment
- Light Fixtures



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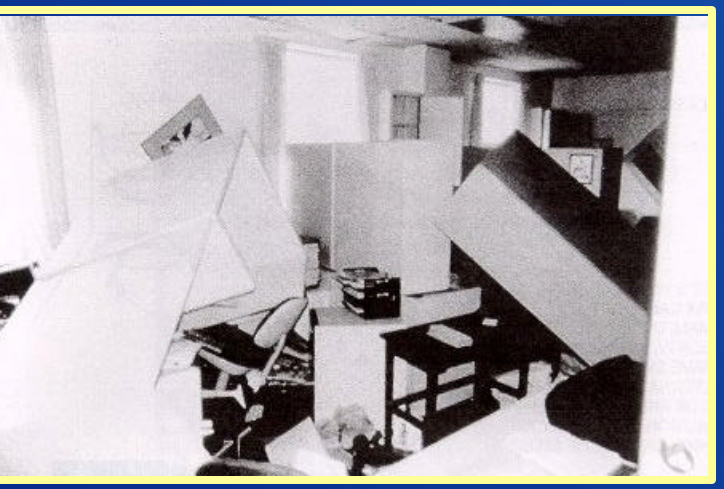
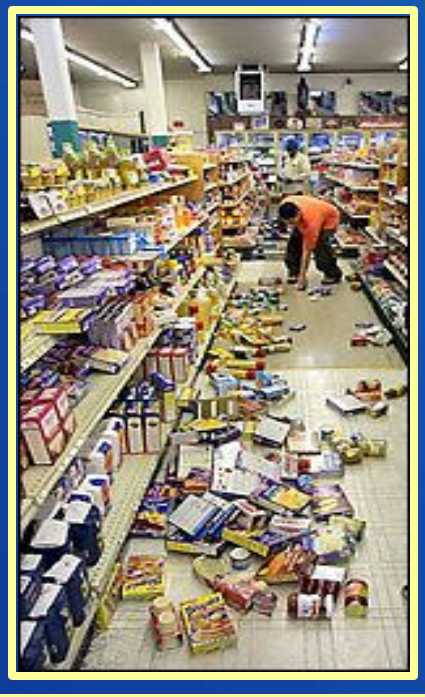
Nonstructural Components

Furnishings and Interior Equipment

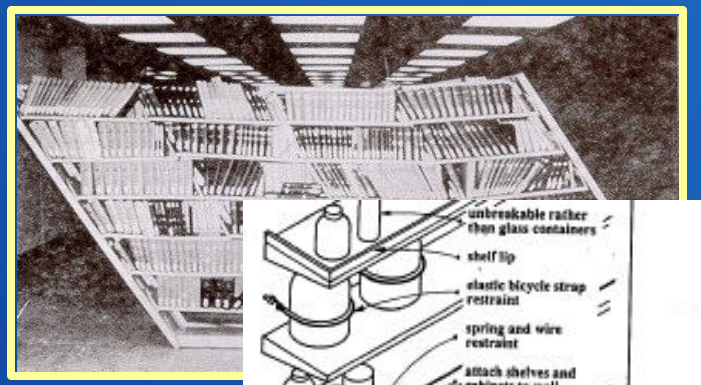
- ✓ Storage Racks, Bookcase
- ✓ Hazard Material Storage
- ✓ Furnishings
- ✓ Computer and Communication Racks
- ✓ Elevators and Conveyors

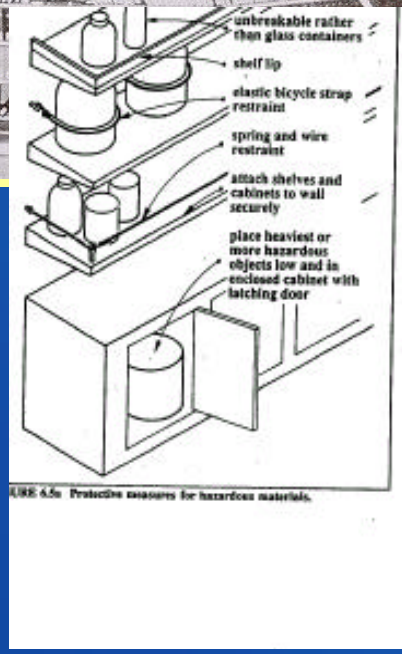
Furnishings and Interior Equipment





Storage Racks, File Cabinets, Bookcases





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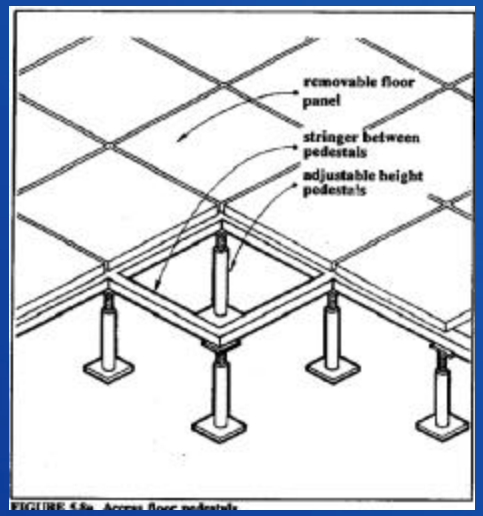
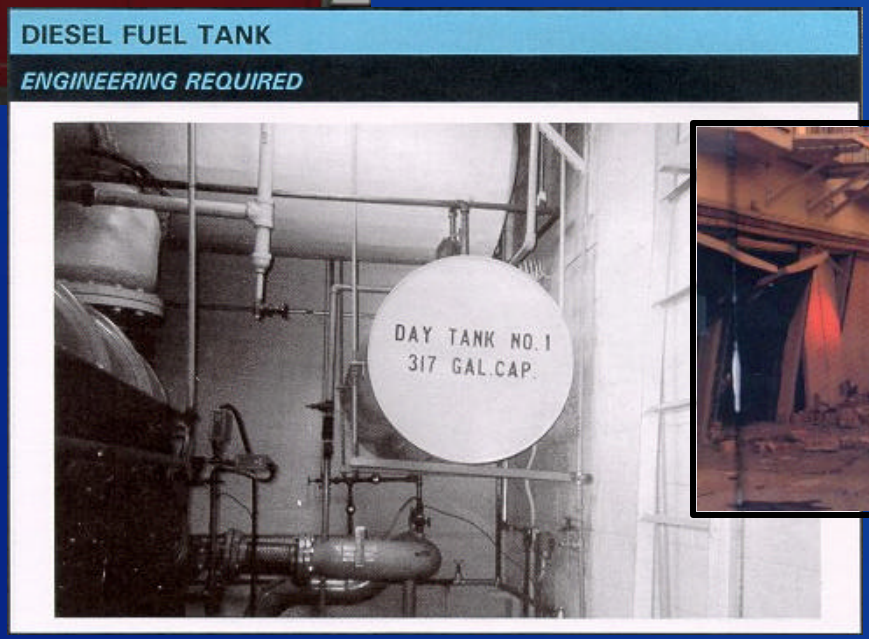
Furnishings and Interior Equipment





- Computer Access Floors
- Hazardous Material Storage

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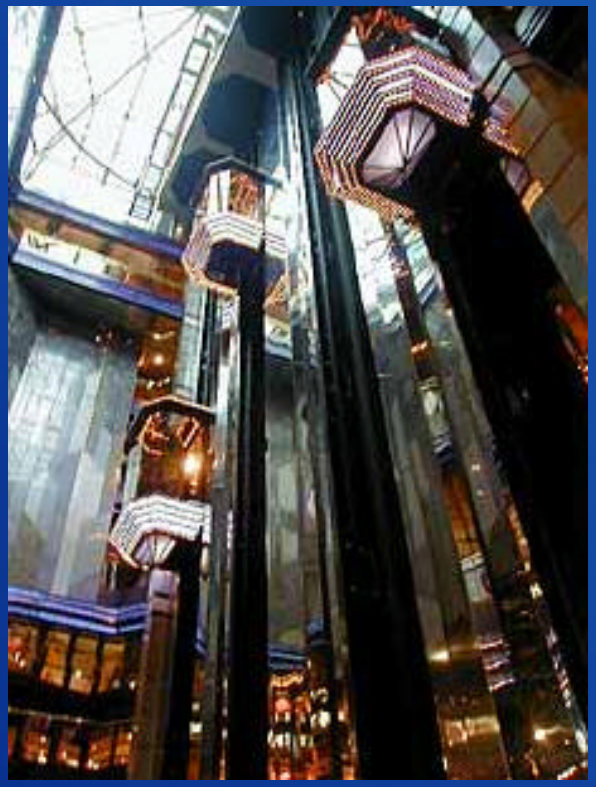
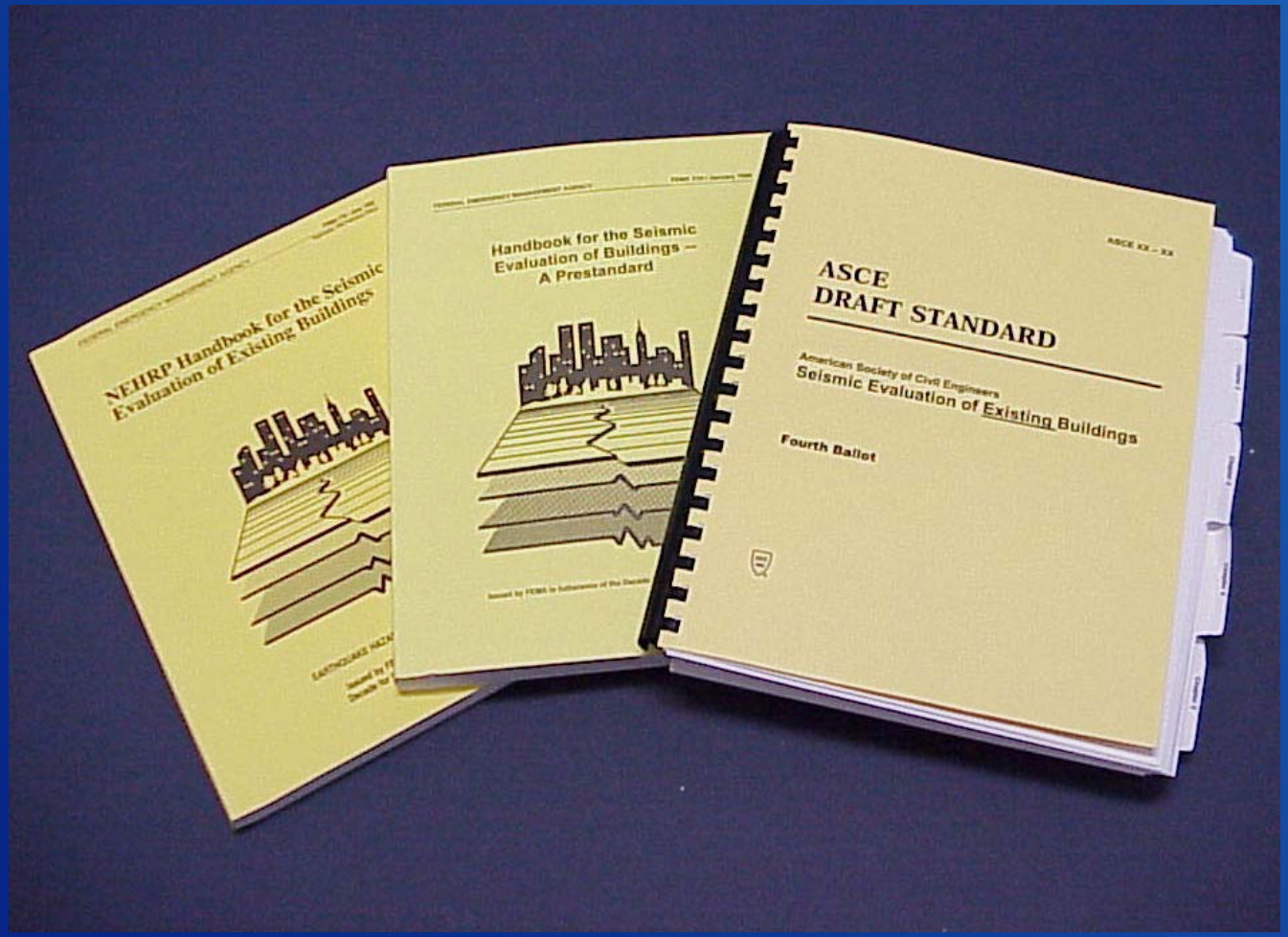
Furnishings and Interior Equipment

Elevators and Conveyors



Hazard Identification Tools



Cursory ID

- FEMA 178
- FEMA 310
- ASCE 31

Seismic Evaluation Check List

Ceiling Systems

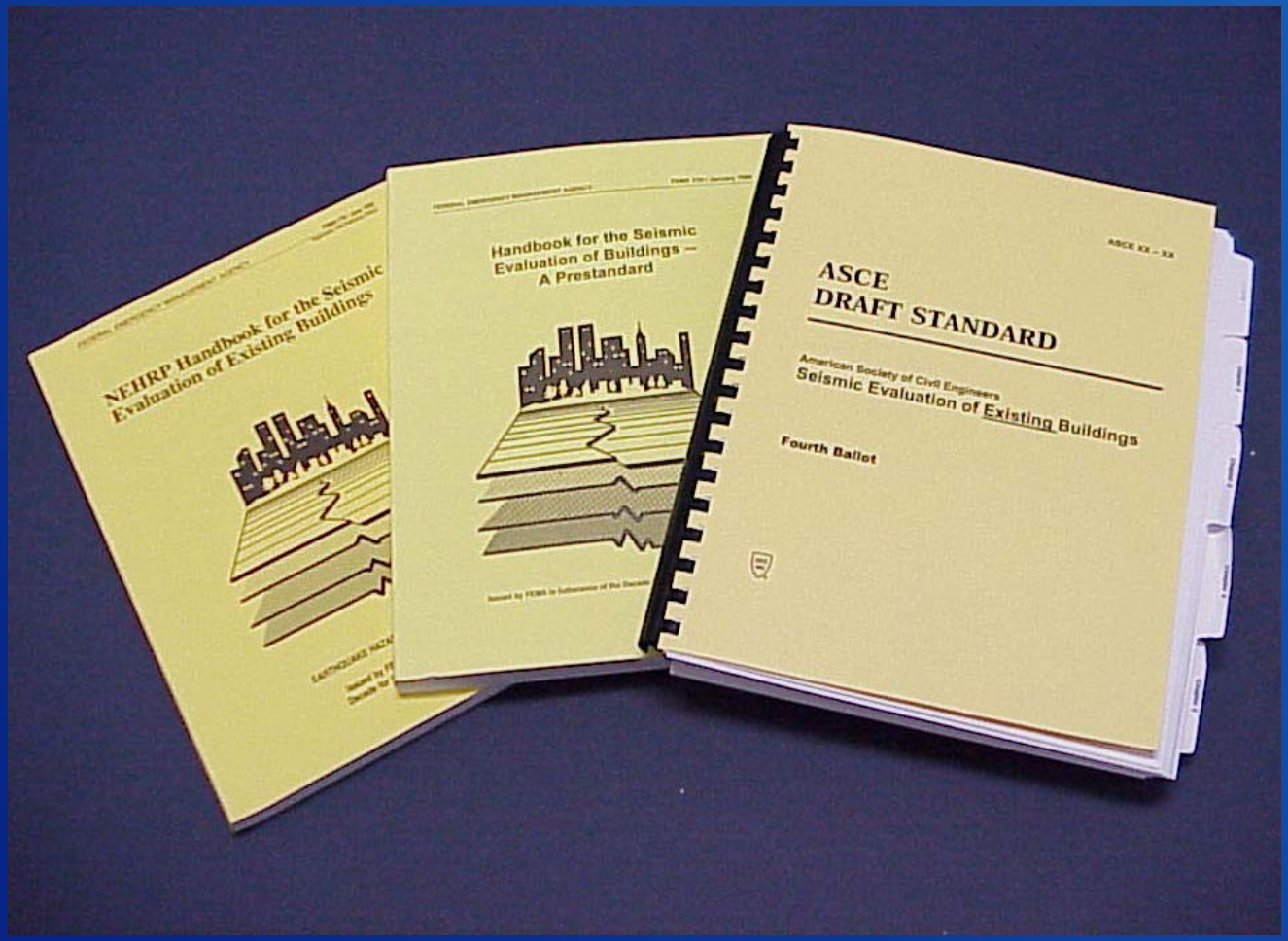
C NC N/A EDGES: The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of ½”. (Tier 2: Sec. 4.8.2.5)

C NC N/A SEISMIC JOINT: The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)

Check lists do not…

- ✓ Consider economic issues
- ✓ Consider other mitigation techniques
- ✓ Provide complete list of nonstructural components
- ✓ Quantify hazards

Hazard Identification Tools



Final ID

- FEMA 356
- FEMA 174
- CA

Reclamations' Approach to Nonstructural Hazards Mitigation:

Identification, Quantification and Mitigation

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Nonstructural Components

Nonstructural Hazards Quantification (NHQ)

Identify, Quantify and Mitigate

- ✓ Room-by-room itemization of nonstructural hazards
- ✓ Classify components
- ✓ Evaluation
- ✓ Categorizes type of repair:
  - ➢ Mitigation by Relocation
  - ➢ Mitigation by Operation & Maintenance (O&M)
  - ➢ Mitigation by others
- ✓ Provide recommendations for mitigation with references from NHRG

Nonstructural Hazards Rehabilitation Guidelines

Catalogs Hazards with Solutions

- ✓ Sections organized by FEMA 356 Chapter 11
- ✓ Details for product data and informative details
- ✓ Excellent reference for previous guidelines

Database Driven

- ✓ Electronic database of all details and product cut sheets
- ✓ Easy to add, delete or update details or products
- ✓ Easy to add text (credits, page numbers or product info)

Training

- ✓ Conferences or Seminars
- ✓ Regional Offices
- ✓ CD Based Automated Training

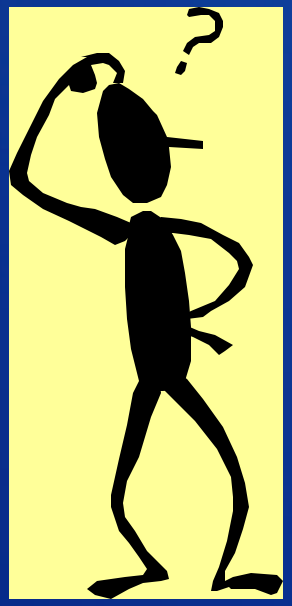
Reclamation Risk Reduction Guidelines

- ✓ Building Selection
  - ➢ High Risk
    - Risk Determined by Seismic Evaluation
  - ➢ High Zone
    - Based on NEHRP B-C soil type (FEMA 154)

N/S Hazards Implementation Plan

- ✓ BOR Regional Contacts
- ✓ Steps in the Process
  - ➢ N/S Hazards Quantification (NHQ)
  - ➢ N/S Hazards Rehabilitation Guideline (NHRG)
  - ➢ Training
- ✓ Building Selection
- ✓ Funding

Nonstructural Hazards Mitigation:
Identification, Quantification and Mitigation



Questions,

Answers

and

Discussion

Program Internet Website
http://www.usbr.gov/ssle/seismicsafety/

Program Intranet Website
http://intra.do.usbr.gov/seismic_safety/

RECLAMATION